

CHAPTER 1

THE GROWTH OF AUTOMOTIVE ELECTRONICS IN APAC, THE NEXT FRONTIER

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*“Where there is an open mind
there will always be a frontier.”*

*Charles F. Kettering, American engineer,
inventor of the electric starter 1876 - 1958*

1.1 ON AUTOMOTIVE ELECTRONICS

In a typical saloon car today, Automotive Electronics are pervasive and critical to the smooth starting and running of the vehicle. Even before the engine starts, electronics powered by integrated circuits (ICs) have already unlocked the car and set up the car, according to the driver's pre-programmed preferences.

From the moment you start the engine and step on your accelerator, numerous ICs have already done their job - sensors assist in getting out of the parking lot, engine control electronics tune the engine performance and safety features power up in standby mode.

As you pull yourself out of the parking lot and adjust the air-conditioning and tune to your favorite music, more electronics kick in. Electronics have long taken care of many of the everyday features of today's car that were once thought luxurious.

Electronics manage interior temperature via the Heating Ventilation & Air Conditioning (HVAC) control. They sense crash situations and automatically fire the airbags. Electronics control vehicle security and open our doors and windows. Today's cars simply would not drive without electronics.

The usage of automotive electronics looks set to continue as drivers demand ever more from their vehicles in terms of performance, safety, comfort, convenience and entertainment. The cars of the future will do even more to avoid accidents, protect and entertain its occupants, and be gentler on the environment.

It is interesting to note that electronics in today's car already exceed 20% of the total vehicle value and this is estimated to increase to 35% within the next 6 years, according to Infineon estimation. The majority of automotive innovations will be driven by electronics innovations enabled by semiconductors.

In this study, Asia Cruising : Rise of Automotive Electronics, it is apt to begin our journey by reflecting on why electronics in vehicles have gained such significance over the past three decades.

1.2 THE ROLE OF AUTOMOTIVE ELECTRONICS

Automotive electronics is a sub-system consisting mainly of semiconductor devices used to sense, compute and actuate the different features/functions in a car. While the transistor was first developed in 1946 by physicist William Shockley, the introduction of electronics to the automotive industry was driven primarily by the needs of engine management in the 1970s with the introduction of electronic fuel injection technology.

Since then, many of the automotive innovations in sophisticated engine management and transmission control have been driven by more powerful micro-controllers, semiconductor switches and sensors. Low cost, high reliability electronics have also made body and convenience applications standard in modern cars. Many of the safety systems in cars would not be possible without the use of electronics. Of late, the development of the infotainment segments has been driven by the convergence of communications and entertainment needs. (Figure 1-1)



Figure 1-1 electronics controls used in various car systems today

Source: Infineon Technologies

The basic function of an electronics system is to sense, compute and actuate. (Figure 1-2) the electronics system operates by sensing the relevant environment, computing the necessary action and executing an action by actuating a mechanical component.

For example, a thermostat senses that the cabin is hot, a micro-controller decides that fast cooling is necessary and triggers maximum compressor and fan performance by switching on some transistors.

At a more sophisticated level, ABS sensors in combination with radar and brake position sensors would provide signals to a powerful micro-controller which could decide in real-time that an accident was imminent. The micro-controller would then prepare the airbag for actuation, move the seats into optimum positions for use with the airbag, and tighten all seat belts.

On impact, pressure and inertia sensors would detect a collision; the micro-controller would trigger the airbags and send out an emergency mobile phone signal to the authorities informing them of the location of the car accident.

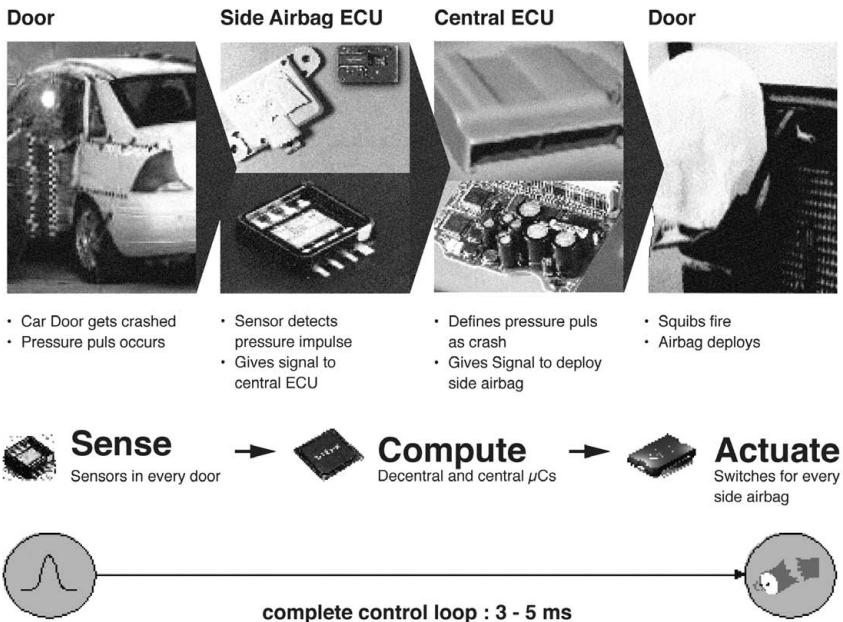


Figure 1-2 Basic function of an electronics system is to sense, compute & actuate

Source: Infineon Technologies

1.3 FROM MECHANICAL TO ELECTRONICS – THE EVOLUTION OF THE AUTOMOTIVE ELECTRONICS INDUSTRY

To understand the phenomenal growth of the automotive electronics in Asia Pacific, we first need to understand the evolution of this industry on a global front.

The dawn of automotive electronics came in the early 1970s, when the only electronics in a car were the radio, the alternator (diodes) and the voltage regulator that controlled the alternator. The last 30 years have seen rapid technological innovations in automotive electronics, driven primarily by advancement in semiconductors and related software that controls the systems.

The replacement of mechanical parts by electronics and also the ‘marriage’ of mechanical actuator parts with electronics, or what is known as ‘mechatronics’, further boosted the growth of the automotive electronics industry we know today.

Automotive electronics innovation has since migrated to different vehicle systems from the days of radio and alternator. (Figure 1-3) illustrates the increasing complexity of automotive electronics and traces this evolution.

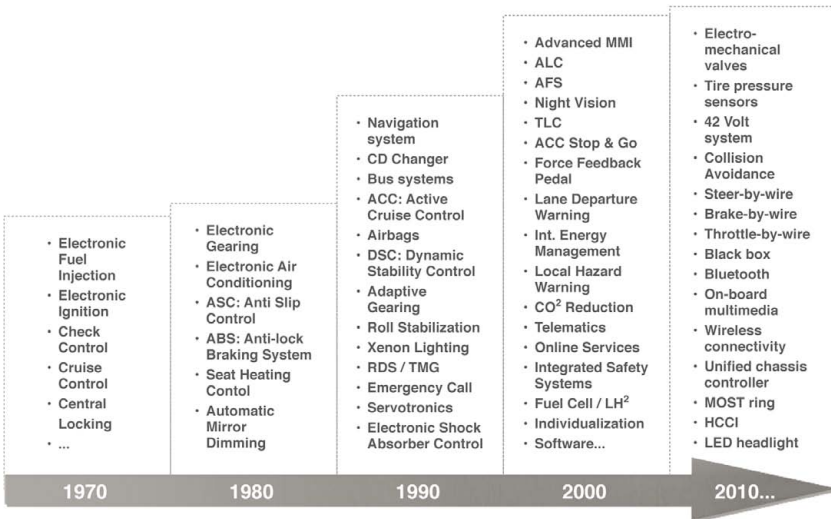


Figure 1-3 Automotive Electronics innovations through the years

- 1970’s: Introduction of electronics for engine controls
- 1980’s: Anti-lock braking introduced
- Early 1990’s: Airbags become standard
- Late 1990’s: Rapid expansion of body electronics – seat motors (body computers), instrument panel lighting, auto locking systems and keyless entry

- Early 2000's to date: infotainment, including sophisticated audio and video; signals sent via satellite (such as the OnStar System); GPS and mapping capabilities; satellite radio
- Late 2000's : Steer-by-wire, wireless connectivity

Infinion Technologies, being a key player and pioneer of this evolution, has contributed significantly and our semiconductors have made vehicles in the past 35 years more comfortable, safe, powerful & environmentally compliant. (Figure 1-4) illustrates these contributions:

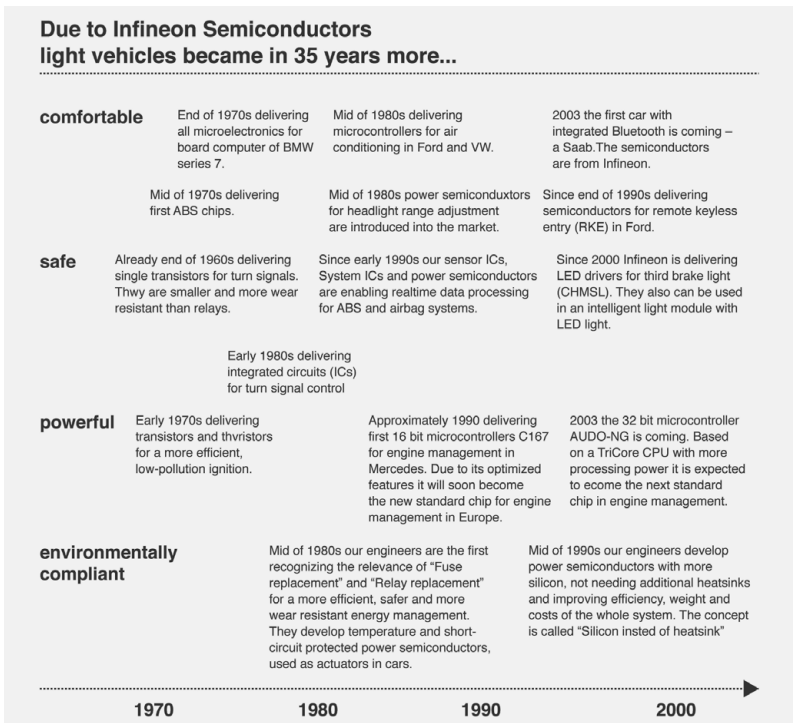


Figure 1-4 History of Infineon Technologies' role in automotive electronics

1.4 GROWTH OF THE AUTOMOTIVE ELECTRONICS INDUSTRY IN ASIA PACIFIC

The automotive electronics industry in Asia Pacific grew out of the offshore transfer of multi-national manufacturers shifting production to Asia for cost and local content reasons.

These were often in the form of joint ventures in order to gain market access. Such ventures focused on manufacturing products developed in the central design centres in Europe and US, often consigning parts purchased centrally.

The products were generally “me-too” products with some cost reduction engineering content. From these beginnings, companies built up design capabilities locally in Asia Pacific to make simple design changes to non-critical systems and to enhance manufacturing efficiency.

As such competencies continued to develop, Asia Pacific design centres of multinationals have been given regional and sometimes global design responsibilities for certain segments of the vehicles and systems portfolio.

In parallel, a competitive local system design industry has developed as both local and global car makers increasingly source products from Asia Pacific to address cost and customization issues. Of course, an increasingly competent component industry has established itself in Asia Pacific to support the growing needs of the automotive electronics industry.

The growth of the automotive electronics industry takes place at three levels:

- Adoption of automotive electronics
- Rapidly growing car markets
- Consumer behavior and wants

1.5 ADOPTION OF AUTOMOTIVE ELECTRONICS IN ASIA PACIFIC

In the early export driven years of the automotive industry in Asia Pacific, the key players either adopted or omitted the electronic features defined by the global automakers. The Asia Pacific automakers would focus more on production prowess rather than innovation as their competitive advantage.

With the increasing importance of the automotive markets in Asia Pacific, especially China and India, automakers are realizing that electronics innovations can complement production innovations in gaining a competitive advantage.

The combination of a need to reduce production cost, increase product quality, meet tighter standards and customize vehicle features – all within shorter business cycles – is driving an increased focus on the role of electronics within the region’s automakers.

Properly designed and implemented, electronics can reduce cost while increasing flexibility and reliability. For example, more than 80% of Infineon’s automotive semiconductor components have zero failure in the field and an overall failure rate of less than 0.2 parts per million thanks to its Automotive Excellence program which addresses quality in the most comprehensive way.

It is founded on four pillars: people, products, processes and production. The employees truly live the credos of “Zero-Defect”, considering the highest quality requirements and understanding the importance of prevention.

Regional automakers and the design teams of global automakers in Asia Pacific are increasing their innovation focus on utilizing technology and capabilities to define a new optimum point on cost versus performance in order to differentiate themselves from other traditional markets.

For example, Hyundai Motor have defined an innovative yet low-cost stability platform called Active Geometry Control Suspension (AGCS) instead of using the traditional yet costly ESC or ESP in their SUVs to raise the cornering stability and ride quality. Instead of using highly sophisticated sensors and actuators to control the braking and torque of each wheel, the AGCS automatically controls and adjusts the rear suspension arms to aid cornering at the limits of adhesion to pass the Fish Hook test (roll over test).

Replacement of mechanical components by electronics e.g. relay replacement by electronic switches, is another means by which electronics can address several needs of the automotive industry at the same time, reducing weight of wire harness and increasing reliability.

The rapid introduction of green technology in the form of hybrid and electric vehicles will strongly increase the use of electronics as the electrical features and increased powertrain complexity will rely on sophisticated electronic control to achieve maximum efficiency and reliability.

Asia Pacific automakers and suppliers have a good opportunity to catch up in the market by utilizing the flexibility of electronics to address their own positioning in the market, whereby neutralizing some of the traditional lead of their competitors elsewhere.

As a result, demand for automotive electronics is growing faster than the vehicle market itself. This is also true globally but especially in Asia Pacific, where we expect a growth rate of 23% in electronics content for automotive, driven by a growth of about 20% in semiconductor consumption in the next five years.

The average semiconductor content of a car in China is expected to grow considerably from US\$110 in 2006 to US\$150 in 2010, yet still only 2/3 of the global average content. In India, the growth is expected to be even more dramatic with the average semiconductor content more than doubling to US\$130 per vehicle.

1.6 RAPIDLY GROWING CAR MARKETS

Asia Pacific is one of the world's fastest-growing car markets, thanks to the rapid rise in the region's middle class and its disposable income. Global automakers project that by 2010, the market will be the largest regional base for automobile production and home to the largest number of vehicle buyers.

China has already seen a massive growth in vehicles production – consumption doubled to 4.4 million units in the short two years between 2001 and 2003, that is known as the country's "Golden Period".

This was triggered by a large jump in domestic consumption which was fed by foreign JV automakers such as GM, VW, Hyundai and other global players. Since 2004, however, China's overall market has settled on a more stable 10-15% growth still mainly driven by domestic consumption.

Another relevant trend is the continuing high growth rate of the local automakers beyond the Golden Period with the market share of local automakers expected to continue to rise from 28% in 2005 to 35 % in 2010. Despite the economic crisis in 2009 on a worldwide basis the Asian car market has not experienced a serious downturn but merely a temporary slowdown. Government stimulus programs coupled with positive economic conditions have in fact driven further growth in the markets. Chery alone is expecting to reach a production volume of 1 million cars by 2010. China's automakers are targeting to achieve their aggressive growth by tapping the export markets both to smaller regional markets as well as to developed markets.

This is especially true as China is positioning itself strongly on the ULCC (ultra low cost car) market which is gaining momentum in today's economic crisis. Below is the chart showing the global ULCC production estimates.

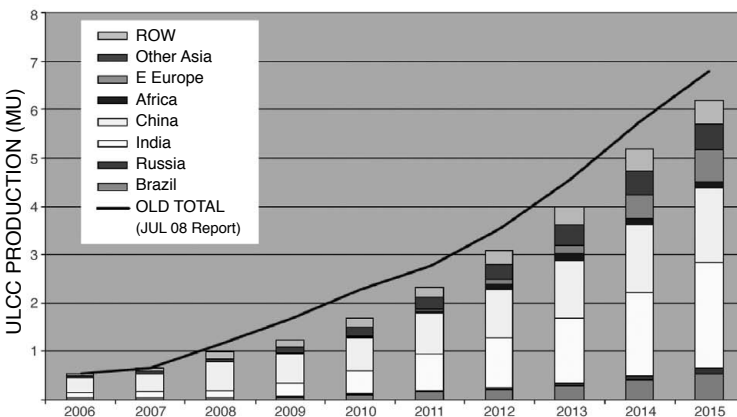


Figure 1-5 ULCC Production (Million Units)

Source: Strategy Analytics

Some regulatory and market characteristics make China one of the most promising market to experiment with electric cars. With less mature infrastructure, it will be easier to establish new support infrastructure such as charging stations to support the new technology. Most Chinese buyers are also purchasing cars for the first time and have not developed particular preferences nor driving experience. Most importantly of all, the Chinese government sees a chance for its car makers to gain ground on foreign rivals, since electric vehicles are simpler to engineer than internal combustion engine. Moreover, this will also help reduce China's dependence on imported energy.

The Ministry of Finance and the Ministry of Science and Technology jointly issued a circular that listed 13 Chinese cities, including Beijing and Shanghai, as pilot cities to demonstrate and popularize the use of clean energy vehicles. The 13 cities include Beijing, Shanghai, Chongqing, Changchun, Dalian, Hangzhou, Jinan, Wuhan, Shenzhen, Hefei, Changsha, Kunming and Nanchang. The objective is to encourage pilot cities to take the lead in popularizing the use of new clean energy vehicles for public services such as buses, taxis, government vehicles and other public vehicles.

These aggressive plans illustrate China's growing commitment to electric vehicles and its strategy to support auto makers developing various types of electric cars and components with research subsidies. Making electric vehicles affordable will be critical for them to have an impact on the environment, as vehicle ownership continue to rise quickly. The millions of new cars being added every year to roads in China could put further pressure on the fragile environment unless cleaner energy alternatives are made more readily available and affordable.

The Chinese electric vehicle technology may not currently lead on battery life, driving range and recharging time, but they focus on affordability and speed to market. In the meantime the Chinese government is encouraging Chinese companies to invest in battery technology, taking advantage of local availability of raw materials for battery production. It would be prudent to presume that China will develop and mass produce leading edge battery technology in due course.

Other than moving towards alternative fuels, China is also developing new fuel economy standards for gasoline vehicles that would require car makers to raise their fleet average fuel economy nearly 18% by 2015, reports The New York Times.

China's current fuel economy standards have targets for 16 different weight classes of vehicles. Deriving an overall average is tricky, but an expert tells the Times that the proposed new rules would raise the fleet average for passenger vehicles to 42.2 miles per gallon (mpg) from 35.8 mpg currently. These stricter regulations will further drive the demand for electronics in applications where it will directly help in the reduction of fuel consumption like electronic power steering, hybrid, electronic transmission, weight reduction etc.

While the Indian car market is currently considerably smaller than China's with 1.99 million cars sold in 2007, the development of this market could have a significant impact on the global vehicle market.

Going its own way, the growth in India has been based mainly on small cars and future growth is expected to be driven by innovation in the creation of an "ultra-low cost" car segment.

Tata Motors have launched their 1 Lakh (100,000 rupee, US\$2500) car which is expected to enable the entry of millions of new consumers into the market. The concept of a ULC (ultra-low cost) vehicle has already attracted the attention of global players such as Nissan, Renault and Ford to the Indian market. This segment will drive automotive innovation in yet another direction as car makers and suppliers attempt to meet emission and safety standards in a low cost package.

The Asia Pacific auto market is experiencing an unprecedented production boom and is poised to become the world's largest market in the near future. (Figure 1-6) While domestic sales are forecast to rise, exports will increasingly drive production in the region. Major automakers will continue to leverage on the capabilities and opportunities in the region to launch more vehicles which are positioned to address the changing needs of the regional and global markets.

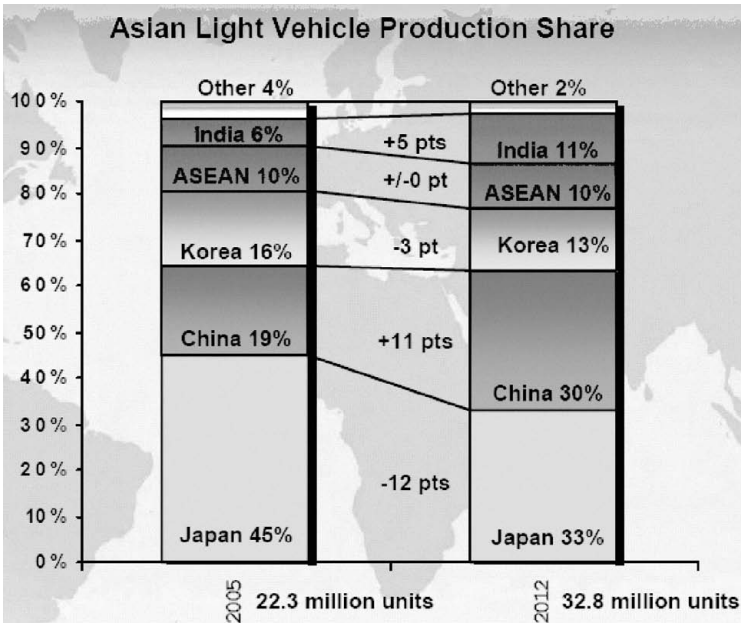


Figure 1-6 Asia Pacific continues to dominate vehicle production, especially China

Source: PWC Institute

1.7 CONSUMER BEHAVIOR AND WANTS

While some governments attempt to set the direction for industries with incentives and regulations, the fundamental changes are driven by the consumers both locally within the region and globally for exports. Consumer needs are driven by factors such as affordability, prestige, mobility, environmental conscience, safety, comfort and a host of other matters.

Such needs vary in their priority in each market. The Chinese market was, for years, driven by prestige as only officials and the very privileged had access to cars. As affordability improved, mobility needs were fulfilled by car ownership but the sense of prestige remained as witnessed by continuing price differential between locally assembled and foreign made models and continued high growth of the premium segment. For example, a China-assembled BMW cost 20% to 30% less compared to a Germany-built vehicle of the same model.

In contrast, the premium segment in India makes up a very small proportion of the market with market share and innovation being directed at the small car segment. Indeed, Hyundai uses India as a production base for small cars for export markets. The ultra-low cost (ULC) segment targeted by the Tata Nano addresses the consumer need for affordability head-on in competition to the motorcycle, the current dominant form of private transportation in India. The major challenge will be for suppliers in this segment to innovate technologically and business-wise in order to create a profitable and sustainable business model.

Korean and ASEAN consumers exhibit an even spread of priorities, of course with affordability varying according to the income difference in each market. In some countries, where single-car families pre-dominate, multi-purpose vehicles (MPV) with 7-8 seats target load-carrying needs while providing a “car” driving experience. Such vehicles, however, are less popular in Australia with its multi-car households, where consumers are more likely to want specialized vehicles such as sports utility vehicle (SUV) for off-road, vans for load carrying, large cars for caravan towing, and expensive brands for prestige.

Consumer demands for features and functions are driven by wealth and exposure to global marketing,

1.8 THE AUTOMOTIVE SEMICONDUCTOR VENDORS LANDSCAPE ASIA PACIFIC

In our discussion on the growth of electronics in car, the semiconductor is ultimately the main backbone that allows for the continuous growth of electronic features in a car. Automotive semiconductors are the driving force in innovations of the future car. (Figure 1-6) illustrates the major applications for semiconductors in the car today and in the next few years.

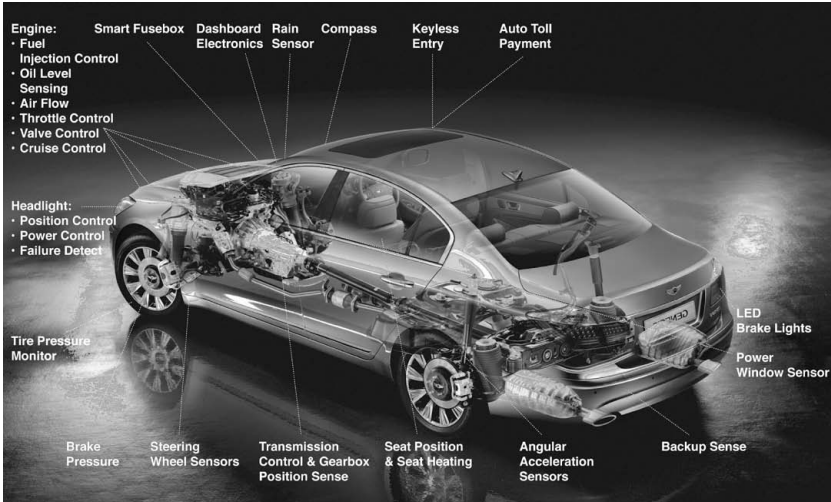


Figure 1-7 Major applications for semiconductor in the car of 2010

Source : Photo courtesy of Hyundai Motor Company

In recent years, many countries are seeing growth in automotive semiconductors. Europe, by far, is still the largest market. While Asia will not replace Europe as the largest market soon, the region is showing the most growth in terms of demand, due to increased automotive production in China.

Until the current financial crisis, the automotive semiconductor market had proven to be very stable over the last few years, contrary to the well-known swings and seasonal demands of the semiconductor market in general.

The demand for cars is amplified many folds, especially in the rapid growing economy of China and some Asian countries. Semiconductor manufacturers are attracted to this market because of the higher relative stability. In this regard, new semiconductor manufacturers intending to tap onto this opportunity have to proceed with careful planning, as production cycles for automotive semiconductors can range from three to five years.

This is a very different scenario from the one seen with consumer or telecom semiconductor production cycles, which can run for only a few months, and rarely exceed two years. The high level of safety and reliability expected of automotive electronics results in demanding testing and qualification requirements which are conducted under strictly controlled processes.

Despite the current slowdown in automotive demand, automotive as a segment continues to be very attractive as an end market owing to its long product lifecycles and high barriers to entry, which tend to result in stable returns.

Long product lifecycles require large upfront commitments but typically result in steady revenue and stringent quality requirements. In addition, the alignment between automotive systems suppliers and semiconductor suppliers creates high barriers to entry. Invariably, you will find that global semiconductor players who serve this segment are also very dominant in the Asia Pacific regions. The top 10 semiconductor vendors in Asia Pacific can be seen on (Figure 1-9).

More indigenous semiconductor players will try to enter the market in the near future. However, they are still limited by technology, innovation, quality and reliability.

2008 Automotive Semiconductor Vendor Shares of \$18.3B Global Automotive Market

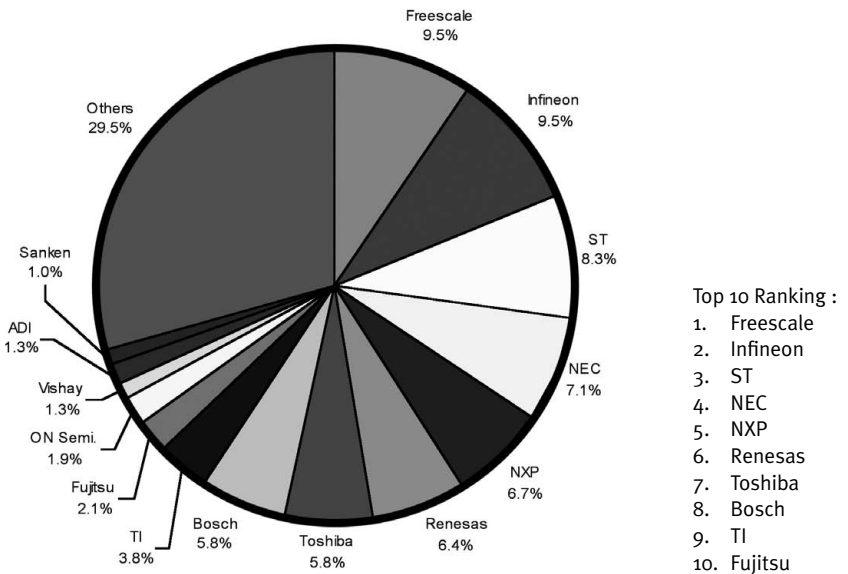


Figure 1-8 Worldwide Automotive Semiconductor Ranking in 2008

Source: Strategy Analytics

**2008 Automotive Semiconductor Vendor Shares of \$3.1B
APAC Automotive Market**

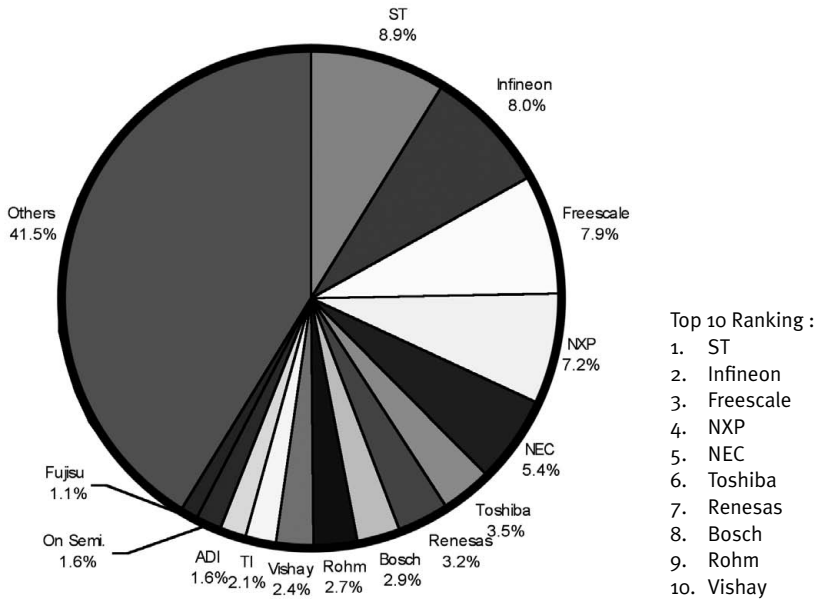


Figure 1-9 Asia Pacific Automotive Semiconductor Ranking in 2008

Source: Strategy Analytics

The automotive semiconductor growth in APAC has been phenomenal over the last few years and this is set to grow at a Compounded Annual Growth Rate of 14% from 2007 USD \$ 2.9 billion to USD \$ 5.6 billion in 2012 (source: Strategy Analytics, January 2009).

To serve this growing market, a typical automotive semiconductor vendor in APAC has to work with numerous channels to serve the eventual customers (the Original Equipment Car Manufacturers). Usually, the most important route to the OEMs would be through Global Automotive Electronic Systems suppliers such as Bosch, Delphi, Continental or through local electronic systems suppliers such as Hyundai Mobis, Hangsheng or UAES.

Electronics distributors are good partners for automotive semiconductor vendors to penetrate the more fragmented segments of the market. Original Design Manufacturers (ODMs), Independent Design Houses (IDHs), Engineering Service Providers (ESPs) or Electronic Manufacturing Services (EMS) firms have limited roles currently in the automotive electronics industry value chain. (Figure 1-10) shows the automotive semiconductor value chain in China. This is also typical of key Asian markets across APAC.

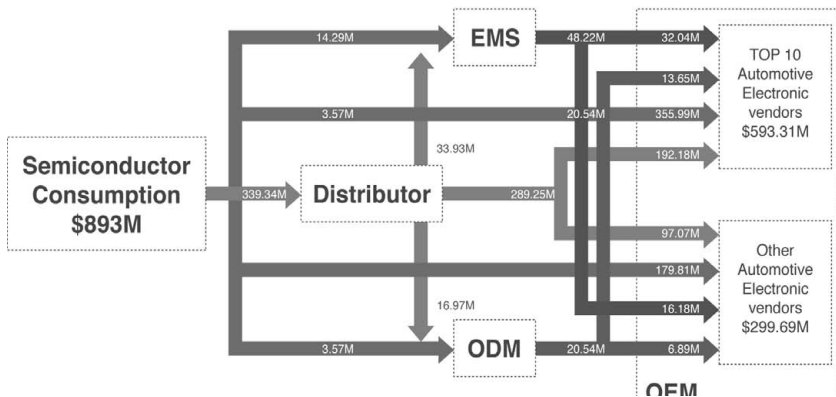


Figure 1-10 Semiconductor Value Chain of Automotive Electronics Production in China, 2007
Source: Isuppli

1.9 CONCLUSION

While the current slowdown in the global automotive industry has affected the Asia Pacific automotive electronics & semiconductor industries, the recovery of the automotive industry in the region is leading the rest of the world.

After falling in the last 2 quarters (Q4 2008 -26% y-o-y to Q1 2009 -49% y-o-y), the sales volumes in China, India and Korea already show strong recovery and stabilization, thanks to both domestic demand and export prowess.

The regional industry continues to gain importance both as a market (with China overtaking the US as the largest car market in Jan 2009) but also as a global innovator in cost and service.

As automotive electronics remain one of the key drivers of the automotive industry, greater demand on innovation, solutions, cost, supply chain and service will point the way forward in Asia Pacific. Key to this is how suppliers adapt to these challenges as the global economy recovers.